Claim 4 recites the limitation "modifying a slip characteristic" in line 1. There is insufficient antecedent basis for this limitation in the claim. How is "modifying a slip characteristic" in the generator. In light of the spec. the subject matter recited "modifying a slip characteristic" is understood as "increasing the rotor resistance".

The notion of "slip characteristic" is described in the specification on page 5, lines 6-17:

> An inherent problem with induction generators is the difficulty in manufacturing them on a standard production line to have precisely repeatable slip characteristics. By design, induction generators run faster than synchronous speed by some small percentage (typically 1.5% at full load) known as its slip, but from one unit to the next this slip varies by a small amount (nominally plus or minus 0.2%). On a 1200 RPM design this amounts to a possible variation of 5 RPM between generators with a nominal full slip range of 18 RPM; since the power output goes from zero at 1200 RPM to full load at 1218 plus or minus2.5 RPM. This slip variability has a huge impact on the load sharing of generators all being driven at exactly the same speed. Thus, the heart of the DGD control function is to regulate the torque experienced by each induction generator and assure that the torques are balanced between generators at any given system load.

In applicant's invention, the series introduction of the transformers switched on and off by the SCR's allows the slip range of the generator to be controlled because the stator voltage is lowered. Lowering the stator voltage is accomplished by the wiring of the transformers in series with the stator windings, controlled by pulse code modulation of the SCR switches.

The ability to change the slip range of the generator is accomplished without changing the rotor resistance. This is because the slip range is proportional to the applied stator voltage.

Another method of changing the rotor slip described in the specification at page 5, lines 23-28, is to add rotor resistance. This method requires the use of a wound rotor induction generator. Employing stator voltage control is preferable to changing rotor resistance because the generator used can be a simple induction machine (such as a squirrel-cage generator) instead of a wound rotor generator.

Claim Rejections - 35 USC § 102

5. - 6. Claims 1, 2 and 6 were rejected under 35 U.S.C. 102(b) as being anticipated by Richardson et al. (U.S. Patent No. 5,083,039).

In Richardson et al. the gear box 14 is a fixed-ratio, step-up transmission. Richardson, et al. states:

> As shown in FIG. 1, the wind turbine 10 includes a variable pitch turbine rotor 12 that is mechanically coupled through a gear box 14 to two 3-phase AC induction generators 16 and 18. The gear box 14 includes a fixed-ratio, step-up transmission, so that the generator rotors rotate at a fixed multiple of the speed of the turbine rotor.

The following language in applicant's claims distinguish the invention over the Richardson et al. patent:

> a single-stage torque-dividing gearbox coupled to said main power input shaft; said torque-dividing gearbox having a plurality of output shafts located around a perimeter of said main power input shaft;

In Richardson et al. the generator controller uses field orientation to regulate either stator currents or voltages to control the torque reacted by the generator. Richardson, et al. states:

> Each of the generators 16 and 18 is controlled separately by generator controllers 38 and 40, which, as explained below, control the torque reacted by the generators by controlling the stator currents or voltages. Shaft speed sensors 42 and 44 monitor the rotor speed of the two generators, respectively, and supply rotor speed information to the generator controllers 38 and 40 and to a torque command device 46. The inverters 28 and 30 are controlled separately by inverter controllers 50 and 52. A power factor controller 54 directs the inverter controllers 50 and 52 to provide power factor correction by shifting the output current with respect to the output voltage. (Col. 5, lines 34-41)

The statements by Examiner attributed to Richardson, patent # 5,083,039, are not correct. The Richardson patent does not refer to a single stage, torque dividing gearbox, only a gearbox.
Richardson states:

> As shown in FIG. 1, the wind turbine 10 includes a variable pitch turbine rotor 12 that is mechanically coupled through a gear box 14 to two 3-phase AC induction generators 16 and 18. The gear box 14 includes a fixed-ratio, step-up transmission, so that the generator rotors rotate at a fixed multiple of the speed of the turbine rotor. (Col. 5, lines 9-16)

The Examiner further argues that Richardson discloses regulating torque step control that is based on local voltage at each generator by a transformer configured as a reactor. This is not a correct statement. The Richardson patent

does not imply nor does it claim to control the generator voltage by a transformer. All transformers are reactors, by their very nature. The transformer (36) shown in Richardson, is configured as a standard pad-mounted transformer for stepping up the voltage from a 480 volt level to a higher voltage level for distribution to a utility grid within a wind farm. The pad-mounted transformer is not used as an active control element for generator torque control.

The Richardson patent does not describe the use of two generators, and controlling the torque between these two generators to balance torque. The purpose of having two generators, is stated clearly in Richardson in column 5, lines 26 through 30:

> The two generators, both which rotate at all times whenever the turbine rotor rotates, are preferred over one generator in the embodiment in order to build a high capacity wind turbine while using readily available generators. (Column 5, lines 26 through 30)

The method of torque regulation claimed in Richardson is Field Orientation control through the use of high-speed transistor switches and position sensors on the generators.

Richardson, et al. states:

> One key feature of the present invention is the use of field orientation control of the rectifier to control generator torque. Field orientation decouples the torque-producing currents or voltages of the generator stator from the flux-producing currents or voltages and thus permits responsive control of generator torque. (Richardson Col. 3, lines 28-33)

This is not what is claimed by applicant. In applicant's claims torque control is provided by lowering the stator voltage and not by using a field-orientation converter as shown in the Richardson patent.

Further, the Examiner states that the Richardson patent in column 2, lines 1 through 5, teaches how to modify the torque characteristics of the individual generators to bring these generators into balance and provide uniform torque distribution. However this is not the case in the Richardson patent. What is described in Column 2, lines 1 through 5 is that the electrical quantities of each phase of the generator is controlled by a torque command device associated with turbine sensors that generate a reference signal indicative of the desired torque along with a generator controller operating under field orientation control:

> "a torque command device associated with turbine parameter sensors that generates a torque reference signal indicative of a desired torque, and a generator controller operating under field orientation control and responsive to the torque reference signal for defining a desired quadrature axis current and for controlling the active switches to produce stator electrical quantities that correspond to the desired quadrature axis current" (Richardson Col.2 line 2)

The method of torque control described in the Richardson patent requires field orientation along with rotor positioning and speed measurement (the shaft speed sensor). The method of torque control of the generators in the present application is through the reduction of stator voltage.

7. Claims 1 and 6 were rejected under 35 U.S.C. 102(b) as being anticipated by Lateur et al. (U.S. Patent No. 5,823,280).

The Lateur et al patent, #5,823,280 does not state that the patent is for an electric power generating device that converts fluid flow of wind or water to electricity as stated by the examiner. The Lateur et al patent is for hybrid electric vehicles and claims a method of using two electric motor/generator combinations and their associated control. The Lateur et al patent does show how a microprocessor is used to regulate the torque between the two motor/generators to make them equal, however there is no discussion about lowering the stator voltage on these devices to regulate torque, therefore the method of torque regulation is entirely different from what is claimed by applicant.

Lateur, et al states:

> Power controller 16 senses the amount of current flowing in each of motor/generators 12,14 and sends signals to microprocessor 26 indicative of the current levels in the motor/generators 12,14. Microprocessor 26 determines whether the currents in such motor/generators 12,14 will cause the sum of the torques being produced by the first and second motor/generators 12,14, multiplied by their respective gear reductions, to be substantially equal to the desired torque on output shaft 62. If not, microprocessor 26 sends a signal to power controller 16 to change appropriately the current in the first and second motor/generators 12,14. (column 7, lines 41 - 52).

As in the Richardson patent the Lateur et al patent discloses a gearbox with two output shafts, one for the first motor/generator and the second shaft for the second motor/generator. The method of control is not the same as the method of control claimed in the present application. Also, the electrical power generated is used to charge a battery not to produce utility grade electricity. Further, in the Lateur et al patent the connection between the two

motor/generators and the output shaft of the gearbox is coaxially. There is only one output shaft on the Lateur et al gearbox, not two as shown on the Richardson patent or 8 as shown in the present application.

The examiner states that the Lateur et al patent is concerned with induction generators and the torque control of such generators. This is incorrect. The Lateur et al patent does not mention induction generators, but discloses Permanent Magnet Alternators.

Claim Rejections - 35 USC § 103

8. - 9. Claim 3 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lateur et al as applied to claim 1 above, and further in view of Crewson et al. (5,905,646).

The Examiner argues that Richardson substantially discloses the claimed invention, except for the added limitations of the generator connecting to a respective primary coil of a transformer and a respective secondary coil is connected to an SCR. Crewson is cited to supply the missing element:

> However, Crewson teaches in figure 6 and figure 7 the generator (51) 1) is connected to a respective primary coil (54) of a transformer (55) and a respective secondary coil (56) is connected to an SCR (57) to assure each current flow through the SCR.
>
> Thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the primary coil and secondary coil as taught by Crewson. Doing so would assure each current flow through the SCR.

The statement by the examiner that the Richardson patent discloses the claimed invention with the primary coil of a transformer connected to a generator and the secondary connected to an SCR is not correct. Neither the secondary nor the primary of the transformer (36) in the Richardson patent is connected to the generator nor are either connected to an SCR.

The examiner further claims that Crewson teaches that a generator is connected to a primary coil of a transformer and a secondary coil to a SCR. This statement is not correct. There are neither generators nor SCR's discussed in Crewson. Crewson does not write about the use of electrical generators nor the use of SCR's. The Crewson patent relates to the modulation of a transformer by transistors (IGBT') to achieve the necessary voltage for operation of a vacuum tube Klystron microwave radio amplifier.

10. Claim 4 was rejected under 35 U.S.C. 103(a) as being unpatentable over Richardson as applied to claim 1 above, and further in view of Herderson (5,140,170). Examiner argues that Richardson substantially discloses the claimed invention, except for the added limitations of modifying a slip characteristic of each generator to match the generator with the greatest slip.

The Examiner states that Herderson teaches modifying the slip of each generator in the system to equal the greatest slip to balance the rpm in each rotor in generator.

Herderson states:

> A power generating system comprising a fluid driven rotor, a generator, and a transmission assembly for coupling the rotor to the generator. The transmission assembly is controlled by an hydraulic circuit which comprises a valve which in a first state prevents flow of operating fluid through the circuit and in a second

> state permits such flow, whereby in the first state torque is transmitted from the rotor to the generator with substantially zero slip, and in the second state the assembly slips so as to permit the rotational speed of the rotor to increase relative to the rotational speed of the generator and maintain a substantially constant torque at the generator. (Herderson abstract)

The Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the slip in each generator as taught by Herderson. Doing so would provide balancing in the rpm of each rotor in generator, 11.

The examiner's statement that the Richardson patent substantially discloses applicant's invention application is not correct. As stated above the Richardson patent employs transistors and field oriented control techniques to achieve torque regulation of the generators. This method is completely different from the one claimed by applicant. As previously stated, the present application states that torque control is achieved through a combination of series applied inductors (transformers wired as inductors) and SCR's to regulate the stator phase voltages. Both of these methods are different and are obviously different to anyone skilled in the art.

With respect to the Herderson patent, the statement that modifying slip of the generator is used to balance the rpm in each generator is not what is claimed by applicant. In applicant's invention, the rpm of each generator is identical due to the use of the Distributed Generator Drive train gearbox. Applicant is not claiming to balance the generator rpm, because it is already balanced through the use the Distributed Generator Drive train gearbox. Applicant is claiming a method of torque control for induction generators by indirect control of the stator voltage.

Claim 5 was rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Richardson and Herderson and further in view of Law (4,636,707)..

Notwithstanding that Claim 5 has been canceled, the statement of the examiner that the Law patent teaches a step increasing of rotor resistance has the effect of increasing the slip characteristic of each generator is not correct. The Law patent does not state this. The Law patent uses a gearbox with two outputs, one for a standard induction generator and a second for the load control of the gearbox through the use of a synchronous generator that is controlled by a SCR switch and a resistive load. This patent does not provide the same means of torque control claimed by applicant. The Law patent provides for torque control through the use of a secondary load and in doing so is a very inefficient means of torque control when compared to applicant's invention. The extra torque from a wind gust is taken up in a resistive load allowing the generator to produce a near constant power output, while the extra torque from a wind gust in the applicant's invention causes the turbine to increase its shaft speed while still generating a constant power output. These are two fundamentally different approaches.

Reexamination of claims 1-4 and 6 and examination of claims 7-12 pending in this application and allowance thereof is respectfully requested.

Respectfully submitted,

Owen L. Lamb

Date: February 4, 2003
PO Box 386
Prescott, AZ 86302-0386

Owen L. Lamb, Reg. #20,831
Attorney for applicant
Phone: (928) 776-8037 or
(805) 689-5666 (cell phone)
Fax: (928) 776-8037

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231, on February 4, 2003

Owen L. Lamb

Owen L. Lamb, Reg. # 20,831

February 4, 2003

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the abstract:

The Abstract has been amended as follows:

ABSTRACT OF THE DISCLOSURE

[A controller for high torque, low RPM wind turbines and ocean current turbines. The turbine consists of a large, input power shaft-mounted, rotating bull-gear with stationary powertrains mounted around its periphery. The gear teeth on the bull- gear rotate past the teeth on pinions, causing the pinions to turn and delivering power to each smaller powertrain. A controller regulates torque experienced by each powertrain to assure that torques are balanced between generators at any given system load. The regulating includes controlling local voltage at each generator in a powertrain by a transformer configured as a reactor, in which coils of the transformers are wired in parallel and are actively modulated with an SCR, solid-state, switching device. Each generator is connected to a respective primary coil of a transformer and a respective secondary coil is connected to an SCR.]

<u>A wind or ocean turbine has an input-power shaft-mounted, rotating bull-gear with smaller stationary pinion-driven powertrains including generators mounted around the periphery of the bull-gear. A controller regulates torque experienced by each powertrain to balance torque between generators at any system load. Regulation includes controlling local voltage at each generator by a transformer configured as a reactor. Coils of the transformers are wired in parallel and actively modulated with an SCR, solid-state, switching device. Each generator output is connected to a respective primary coil of a transformer and a respective secondary coil is connected to an SCR. By using pulse width modulation, the SCR is gated on and off for a portion of a 60 Hz cycle. By adjusting the duty cycle of SCR gating, any voltage between 80% and 100% is attained to satisfy immediate torque requirements.</u>

In the specification:

The paragraph beginning at page 3, line 18, has been amended as follows:

FIGURE 2 shows a schematic view of the induction generator of the present invention in parallel configuration;

The paragraph beginning at page 9, line 13, has been amended as follows:

Another [import] important facet of the torque regulation capabilities of the SCR-T controller is its ability to increase/decrease slip by reducing torque, in response to variations in the prime mover input torque. This capability is especially significant to wind and ocean current turbine control where variations in the input torque occur on a regular basis as the rotors are subjected to wind gusts and surges in ocean current velocity.

In the claims:

1. For use with an electric power-generating device that converts fluid flow of wind or water to electricity including a rotor having blades that rotate in response to fluid flow; a main power input shaft coupled to said rotor; a single-stage torque-dividing gearbox coupled to said main power input shaft; said torque-dividing gearbox having a plurality of output shafts located around a perimeter of said main power input shaft; and, a plurality of sub-powertrains, each one of said sub-powertrains including a generator coupled to a respective one of said output shafts, each said generator having a local generator voltage output, a controller method comprising:

Connecting, for each generator, a transformer configured as a reactor, each transformer being connected to a respective local generator voltage output; and,

Regulating torque experienced by each said generator to assure that torques are balanced between generators at any given system load by actively modulating said transformer.

2. The method of claim 1 wherein said [regulating step includes controlling local voltage at each said generator by a transformer configured as a reactor, in which] coils of said transformers are wired in parallel and are actively modulated with [an SCR,] a solid-state[,] switching device.

3. The method of claim 2 wherein each generator is connected to a respective primary coil of a transformer and a respective secondary coil of a transformer is connected to [an SCR] said solid-state switching device.

4. The method of claim 1 wherein each generator has a slip characteristic and said regulating step includes modifying said slip characteristic of each generator to match [the] a generator with the greatest slip.

6. In a system of mechanically coupled multiple induction generators driven by a single rotor, a main power input shaft coupled to said rotor; a single-stage torque-dividing gearbox coupled to said main power input shaft; said torque-dividing gearbox having a plurality of output shafts located around a perimeter of said main power input shaft; each of said multiple induction generators being coupled to a respective one of said output shafts, each said generator having a local generator voltage, a method of regulating torque experienced by each induction generator to assure that torques are balanced between generators at any system load comprising steps of:

A. Monitoring torque on each individual generator;

B. Determining relative torque balance between said multiple generators; and,

C. Modifying torque characteristics of said individual generators to bring said generators into balance to provide uniform torque load distribution between said multiple generators.